Summary of Activities in 2003-04 and Plans for 2004-2005

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Outline

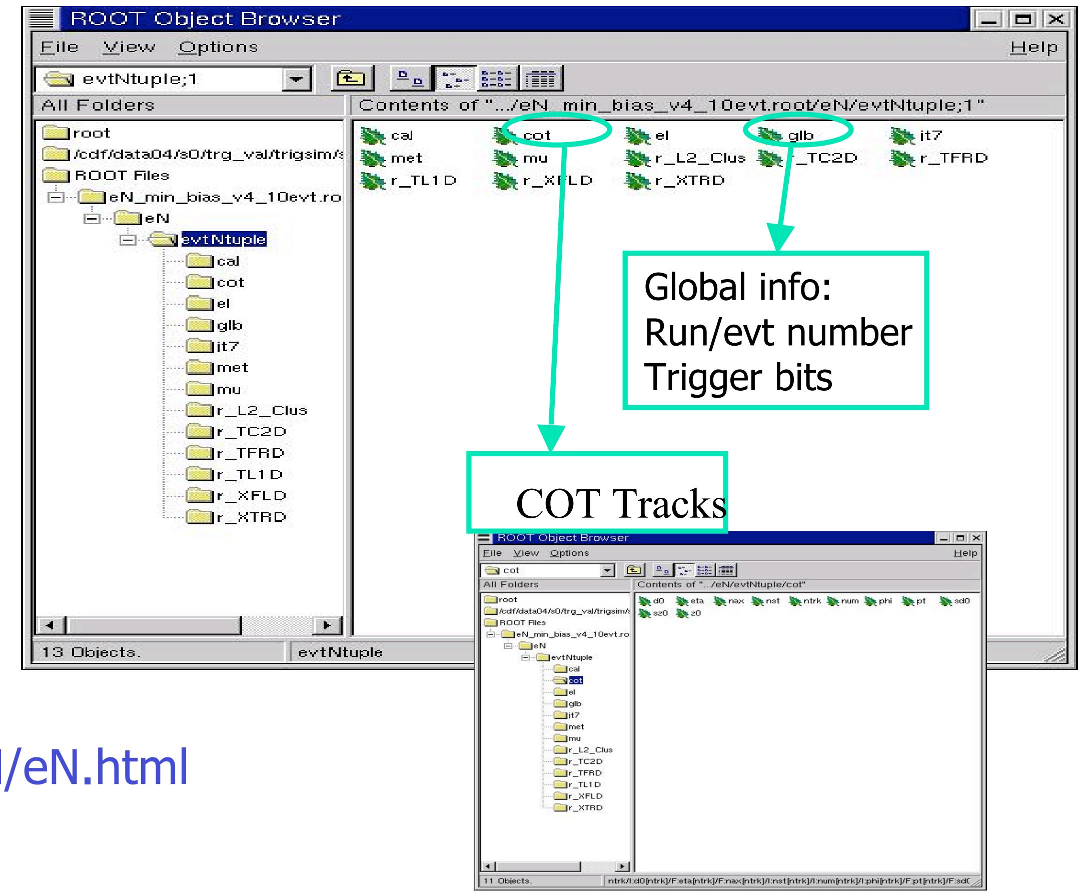
- CDF activities
  - Service work
  - Physics analysis
    - Search for LeptoQuarks
- ATLAS
  - Service work
  - Test beam data
  - Plans for next year

Service work at CDF

CDF eventNutple - eN

- Event information is translated into ROOT branches:
  - High Level Objects
  - Trigger Information
  - Raw Data Information
  - Simulated information

eN is one of the three main analysis tools used in CDF



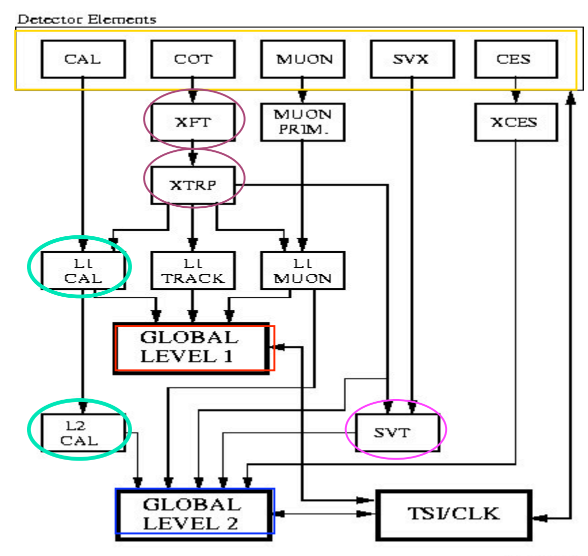
http://ncdf70.fnal.gov:8001/talks/eN/eN.html

Service work at CDF (cont'd)

TRGSim++

- set of (C++) packages which emulate the various trigger levels decision steps (CDF trigger is fully digital)
  - offline tool to calculate rates and efficiencies;
  - online monitoring tool.
- TRGSim++ modules run off detector raw data and produce emulated trigger data identical to real hardware data.
- Trigger decision steps: A_C++ modules, organized in packages:
  - CalTrigger
  - MuonTrigger
  - XFTSim
  - SVTSim
  - XTRPSim
  - L2/L1GlobalTrigger
  - TriggerMods
  - TriggerObjects

RUN II TRIGGER SYSTEM



http://ncdf70.fnal.gov:8001/trigsim/trgsim.html

Service Work (Cont'd)

- CDF is producing a great amount of papers
  - Internal review committees are set for each analysis
    - Still some Run I analysis

- I am godparents committee chair for 2 analysis:
  - Search for ZZ and WZ production in pp collisions at √s = 1.96 TeV
    - leptonic decay channels , and ZW *l1ll and ll*. In a 194 pb-1 data sample collected at the collider detector at Fermilab, 4 ZZ and ZW candidates are found with an expected standard model background of 2.29 ± 0.42 events. 95% CL limit set on the production crosse section.
  - V+A Fraction in Top Decay at CDF at √s =1.8 TeV
    - Measurement of the decay rate f_{V+A} of W produced in top decayin the hypothesis of a non standard V+A structure of the tWb vertex. f_{V+A} < .61 at 95% CL

Searches for LeptoQuarks

- Why Leptoquarks ?
- Current Results
  - First and Second Generation Leptoquarks
  - Final Run II results
  - Comparison with LHC prediction
- Plans for next year
  - Third Generation: □ - see Hao's talk

Theoretical Motivation

- **Leptoquarks (LQ)** are hypothetical particles which appear in many SM extensions to explain **symmetry between leptons and quarks**
  - SU(5) GUT model
  - superstring-inspired models
  - 'colour' SU(4) Pati-Salam model
  - composite models
  - technicolor

•**LQs can have**:

–spin 0 (scalar)

•couplings fixed, i.e., no free parameters

•Isotropic decay

–spin 1 (vector)

•anomalous magnetic (k_G) and electric quadrupole (λ_G) model-dependent couplings

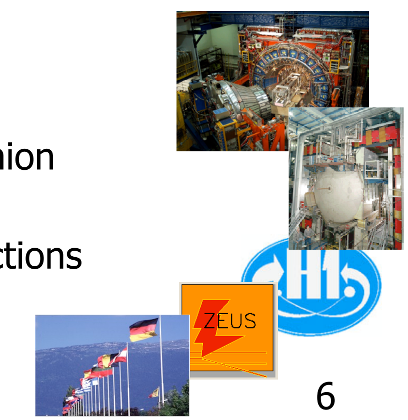
–Yang-Mills coupling: $k_G = \lambda_G = 0$

–Minimal coupling: $K_G = 1$, $\lambda_G = 0$

–Decay amplitude proportional to $(1 + \cos\theta^*)^2$

•LQs are **coupled to both leptons and quarks** and carry SU(3) color, fractional electric charge, baryon (B) and lepton (L) numbers

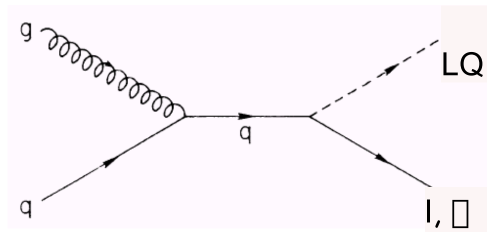
- **Experimental evidence searched:**
  - indirectly: LQ-induced 4-fermion interactions
  - directly: production cross sections at collider experiments



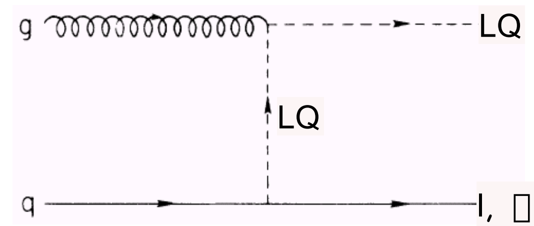
LQ at Hadron Colliders

- **Single production**
  - strongly depends on λ
  - possible signatures:
    - l^+l^- + jet
    - $l\nu$ + jet
    - $\nu\nu$ + jet
  - Main background: Zjet & tt

qg→ ℓ LQ,



qg→ ν LQ

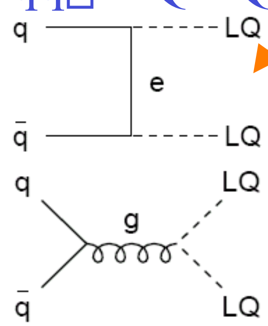


Not considered here

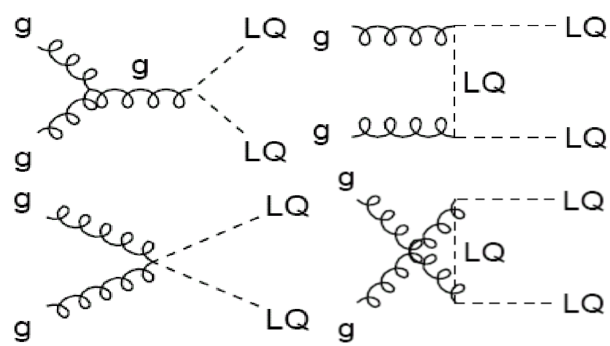
- λ dependent process
- does not contribute significantly to 2nd & 3rd generation

- **Pair production**
  - Practically independent of Yukawa coupling λ (only g-LQ-LQ vertex)
  - Depends mainly on LQ mass

$q\bar{q}$→ LQ LQ



gg→ LQ LQ



LeptoQuark Decay

$\beta = Br(LQ \rightarrow lq)$

Each generation can decay into 3 final states:

Exclusive to the Tevatron

	1^{st} Generation	2^{nd} Generation	3^{rd} Generation
$\beta = 1$	$LQ\,\overline{LQ} \rightarrow e^- e^+ q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \mu^+ \mu^- q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \tau^+ \tau^- q\bar{q}$
$\beta = 0.5$	$LQ\,\overline{LQ} \rightarrow e^{\pm} \nu_e q_i q_j$	$LQ\,\overline{LQ} \rightarrow \mu^{\pm} \nu_\mu q_i q_j$	$LQ\,\overline{LQ} \rightarrow \tau^{\pm} \nu\, q_i q_j$
$\beta = 0$	$LQ\,\overline{LQ} \rightarrow \nu_e \nu_e q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \nu_\mu \nu_\mu q\bar{q}$	$LQ\,\overline{LQ} \rightarrow \nu_\tau \nu_\tau q\bar{q}$

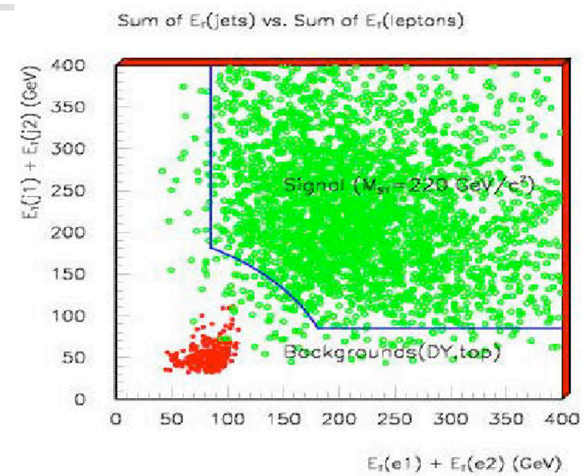
This talk! →

$LQ\,LQ \rightarrow llqq$	$2l+2j$	$BR = \beta^2$
$LQ\,LQ \rightarrow l\nu qq$	l+MET+2j	$BR = 2\beta(1-\beta)$
$LQ\,LQ \rightarrow \nu\nu qq$	MET+2j	$BR = (1-\beta)^2$

1st Gen - eejj

Selection

- ✓ 2 electrons (CC,CE) $E_T > 25$ GeV
- ✓ 2 jets, $E_T(j1) > 30$ GeV, $E_T(j2) > 15$ GeV
- ✓ Z Veto ($76 < M_{ee} < 110$) GeV

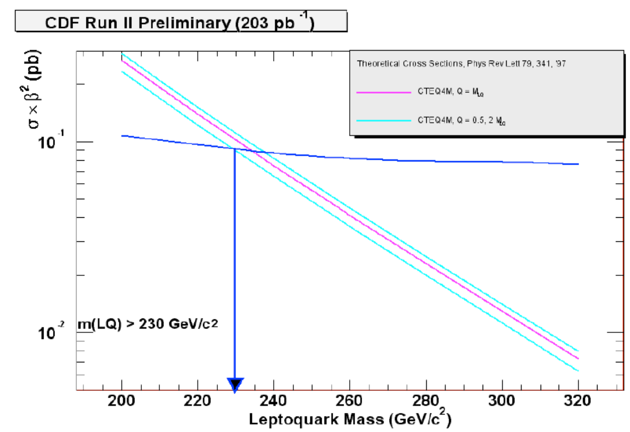


- ✓ Electrons/Jets: $E_T^{j1(e1)} + E_T^{j2(e2)} > 85$ GeV
- ✓ $((E_T(j_1) + E_T(j_2))^2 + (E_T(e_1) + E_T(e_2))^2)^{1/2} > 200$ GeV

Signal Acceptance ~(32 - 40)%

M(LQ) ~200 - 320 GeV/c²

Luminosity	203 pb^{-1}
Acceptance	(32-42)%
Background	$6.2^{+3.1}_{-2.5}$
Observed	4

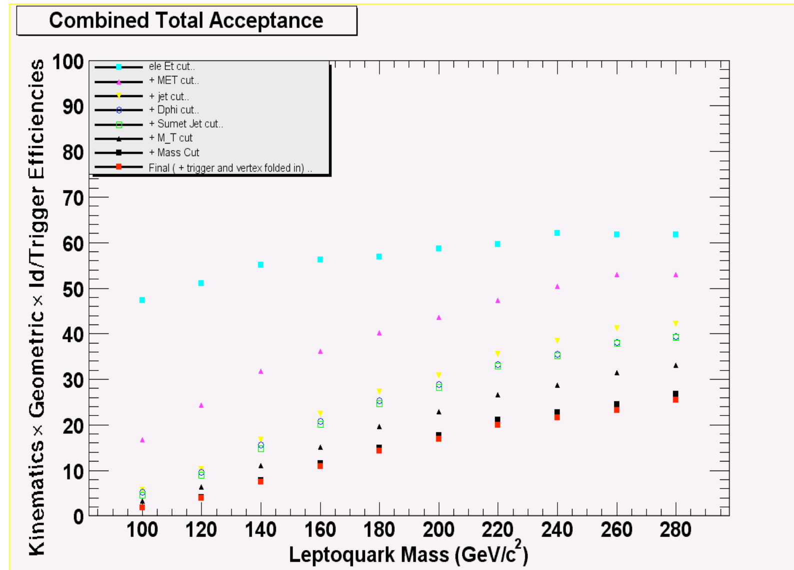


Exclude at 95% CL $M_{LQ} < 230$ GeV/c²

1st Gen – e□jj

Selection

- 1 central electrons with $E_T > 25$ GeV
- MET > 60 GeV
- Veto on 2nd electron, central loose or Plug
- 2 jets with $E_T > 30$ GeV
- □□ (MET-jet) > 10°
- $E_T(j1) + E_T(j2) > 80$ GeV
- $M_T(e-□) > 120$
- LQ mass combinations



Signal Acceptance ~(2 - 22)%

m(LQ) ~100-280 GeV/c^2

The invariant mass of the electron-jet system and the transverse mass of the neutrino-jet system are selected where the jet assignment is made such that the difference between the electron-jet mass and the neutrino-jet transverse mass is minimized.

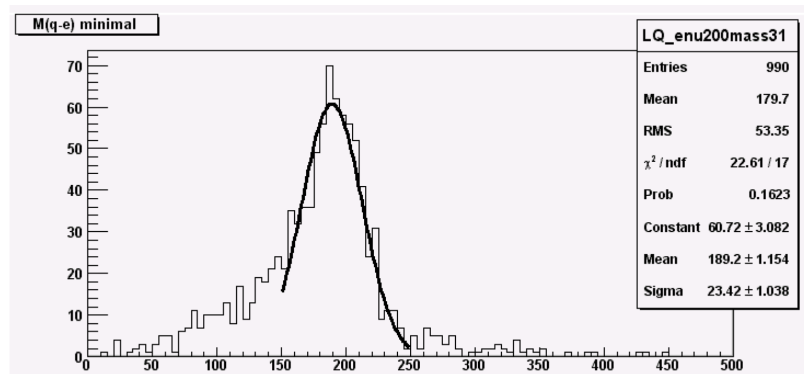
eνjj - Mass combination

The peak of the *ej* histogram is fitted with a gaussian

rough estimate of the spread of the distribution in the signal region.

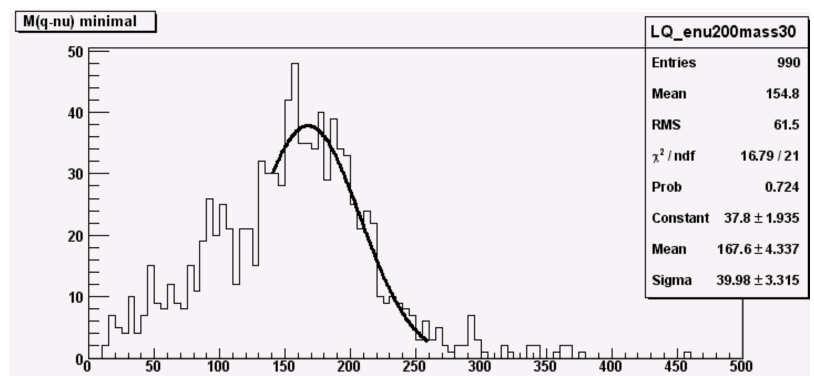
Several masses (120-160-200-240-280) tested:

σ_e ~ 15%.



The ν-*q* transverse mass distribution is fitted including the high mass tail end, with a Gaussian to estimate the signal spread.

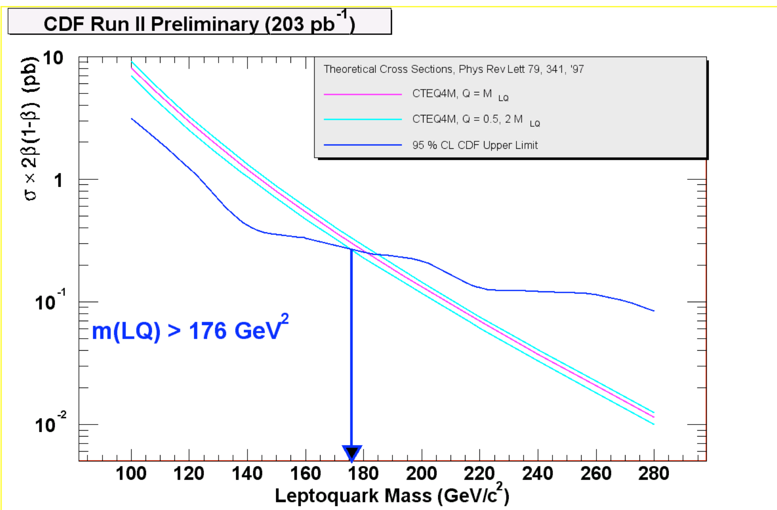
σ_ν ~ 25%.

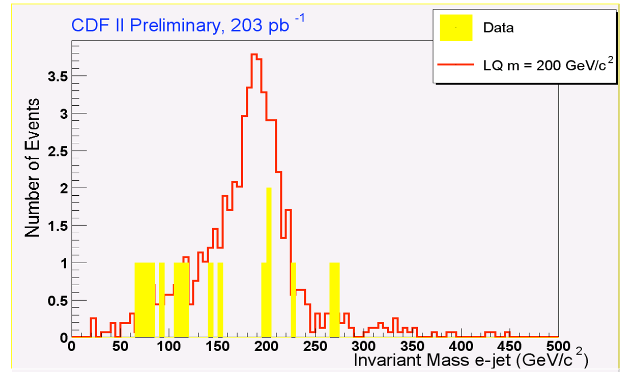


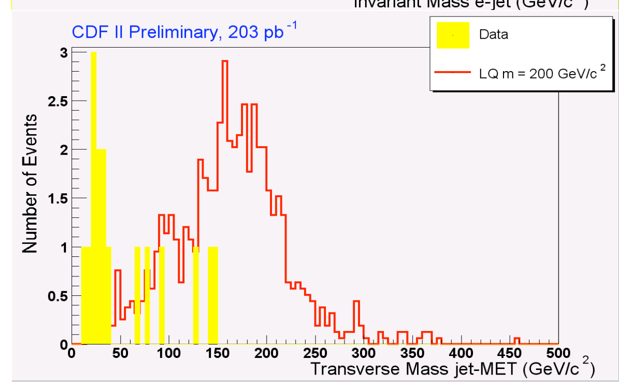
3σ cut around the nominal mass to select LQ candidates of a given mass

e□jj Results

Mass	100	120	140	160	180	200	220	240	260	280
W+2 jets	1.5±0.9	1.5±0.9	1.5±0.9	2.5±1.13	2.5±1.13	2.5±1.13	2.0±1.0	2.0±1.0	1.5±0.88	0.5±0.5
top	2.7 ±0.6	3.3 ±0.6	3.12 ±0.5	2.8 ±0.5	2.5 ±0.5	2.03 ±0.4	1.63 ±0.4	1.08 ±0.3	0.8 ±0.22	0.6 ±0.21
Z+jets	0.05 ±0.01	0.05±0.01	0.08±0.02	0.08±0.02	0.08±0.02	0.08±0.02	0.06±0.02	0.06±0.02	0.04±0.01	0.04±0.01
Total	4.3±1.03	4.9 ±1.05	4.7 ±1.1	5.4 ±1.2	5.0 ±1.2	4.6 ±1.23	3.7 ±1.06	3.1 ±1.0	2.3 ±0.9	1.1 ±0.6
Data	7	6	4	4	4	4	2	2	2	1



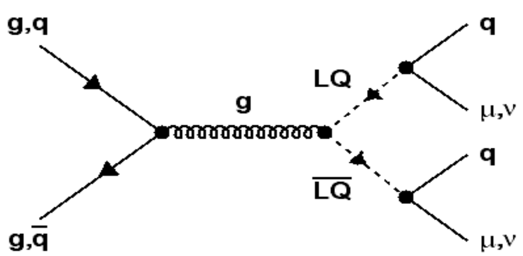




Luminosity 203pb^{-1}

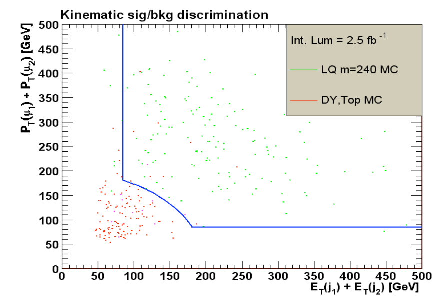
Exclude at 95% CL M_{LQ}<176 GeV/c^2

2nd Gen. -- $\mu j\ \mu j$



Selection

- 2 muons with $P_T > 25$ GeV
- 2 jets with $E_T(j1,j2) > 30,15$ GeV
- Dimuon Mass Veto:
- $76 < M_{\mu\mu} < 110$, $M_{\mu\mu} < 15$ GeV

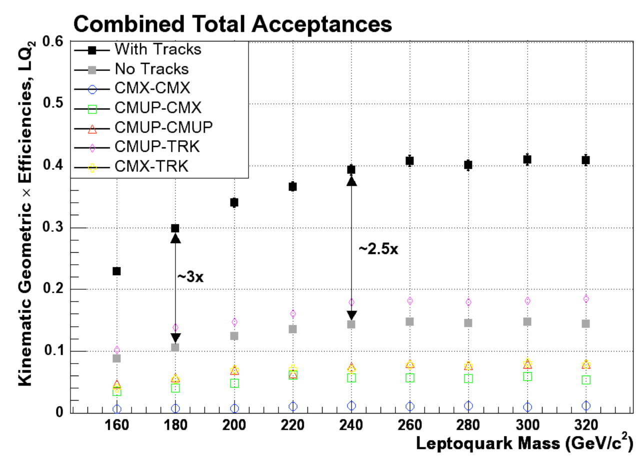


- $E_T(j_1) + E_T(j_2) > 85$ GeV and $P_T(\mu_1) + P_T(\mu_2) > 85$ GeV
- $\left((E_T(j_1) + E_T(j_2))^2 + (P_T(\mu_1) + P_T(\mu_2))^2 \right)^{1/2} > 200$ GeV

SM Backgrounds

- Drell-Yan+2jets
- Fakes
- Top (W□ □□)

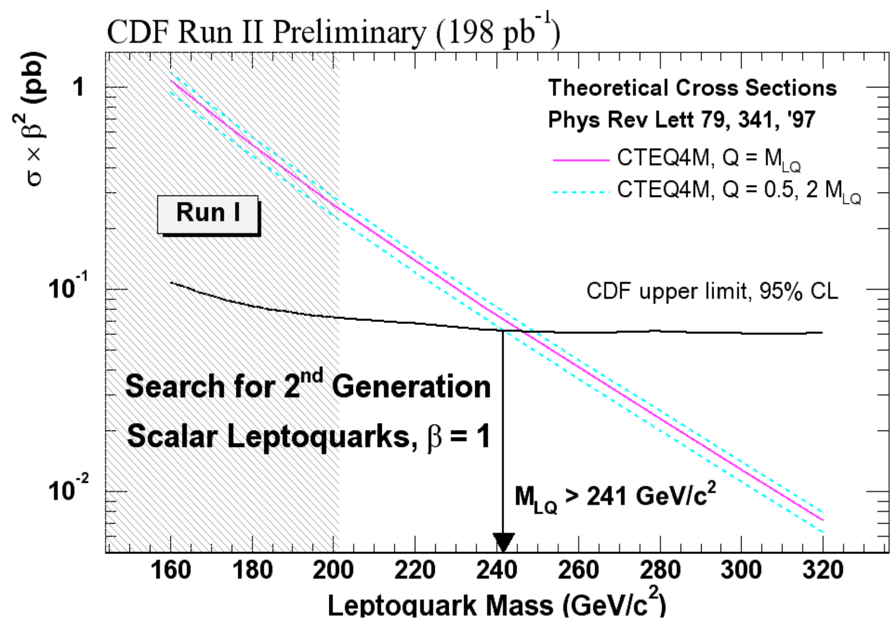
Muons and MIP tracks to increase acceptance



2^{nd} Gen. -- $\mu j\ \mu j$ Results

Luminosity	$198 pb^{-1}$
Background	3.1 ± 1.2
Observed	2

$M_{LQ} < 241$ GeV/c^2 at 95% CL



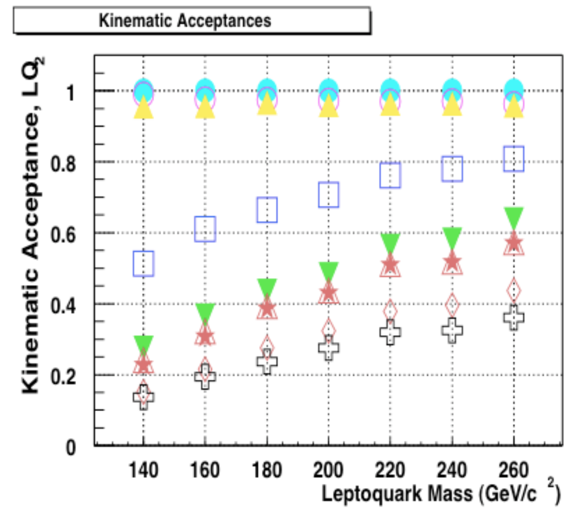
2^{nd} Gen - □□jj

SM background

- W +2jets
- Top (l + jets and dilepton)
- QCD/Fakes

Selection

- Z veto (tight/loose pair)
- No 2^{nd} muon (CMUP, CMX, or stubless)
- $P_T(\mu) > 25$ GeV
- $\not{E}_T > 60$ GeV
- 2 jets, @ E_T>30GeV
- $\Delta\phi(\mu,\not{E}_T)<175°$, $\Delta\phi(\not{E}_T,\text{jets})>5°$
- $E_T(\text{jet1})+E_T(\text{jet2}) > 80$ GeV
- $M_T(\not{E}_T,\text{Muon}) > 120$ GeV/c^2
- Mass Cut



$|M(\mu,j_1) - M_{LQ}| < 2\sigma_1$

or

$|M(\mu,j_2) - M_{LQ}| < 2\sigma_2$

Sigma's determined from generator-level matched reconstructed objects.

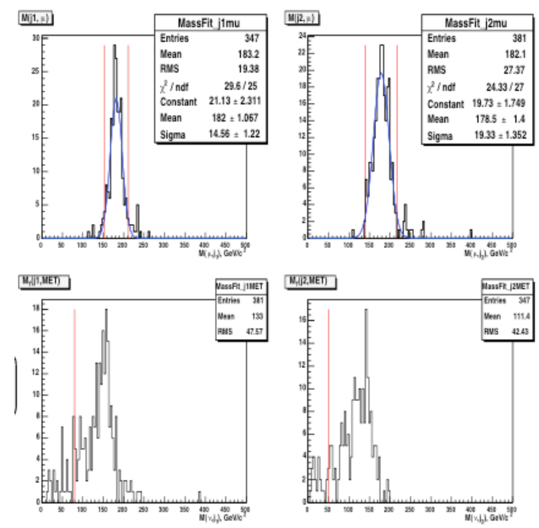
$M_T(\not{E}_T,j_1) > T_1(\min)$

or

$M_T(\not{E}_T,j_2) > T_2(\min)$

$T_1(\min) = 20 + (M_{LQ} - 120)$ GeV/c^2

$T_2(\min) = 20 + (M_{LQ} - 120)/2$ GeV/c^2



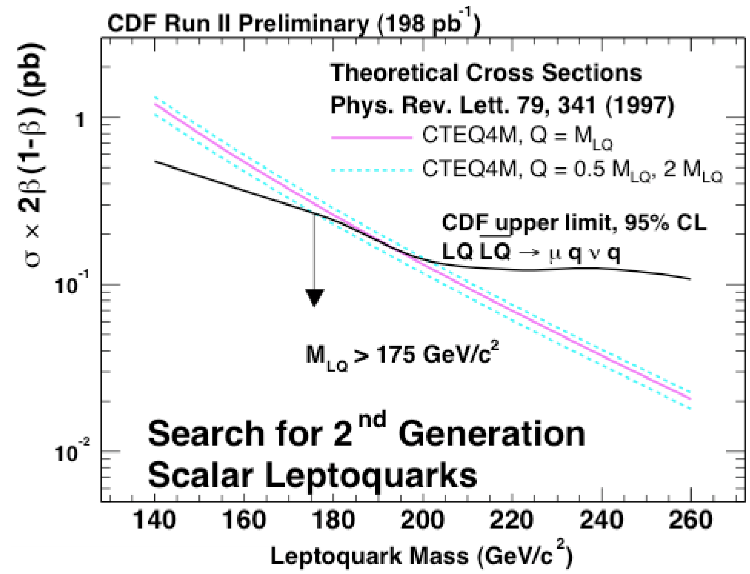
□□jj - Results

Final Selection

	140	160	180	200	220	240	260
W	0.92 ± 0.06	1.44 ± 0.10	1.44 ± 0.10	1.67 ± 0.11	1.65 ± 0.11	0.93 ± 0.06	0.44 ± 0.03
Top	1.69 ± 0.21	1.84 ± 0.23	1.35 ± 0.17	1.00 ± 0.39	0.80 ± 0.29	0.67 ± 0.08	0.52 ± 0.06
Z	0.18 ± 0.01	0.22 ± 0.02	0.19 ± 0.01	0.18 ± 0.01	0.14 ± 0.01	0.05 ± 0.00	0.04 ± 0.00
QCD	0.29 ± 0.29	0.29 ± 0.29	0.29 ± 0.29	0.29 ± 0.29	0.29 ± 0.29	0.29 ± 0.29	0.29 ± 0.00
Total	3.09 ± 0.57	3.74 ± 0.62	3.22 ± 0.56	3.08 ± 0.53	2.83 ± 0.51	1.94 ± 0.44	1.30 ± 0.39
Data	3	3	2	0	0	0	0

Luminosity **198pb^{-1}**

Exclude at 95% CL
$M_{LQ} < 175$ GeV/c^2



At the End of TeVatron Run II

Assumptions:

Same acceptances as now

Number of events observed = number of predicted background

Same errors

□= 1 mass limit up to 250-300 GeV/c^2

□ = 0.5 mass limit up to 230-280 GeV/c^2

Preliminary

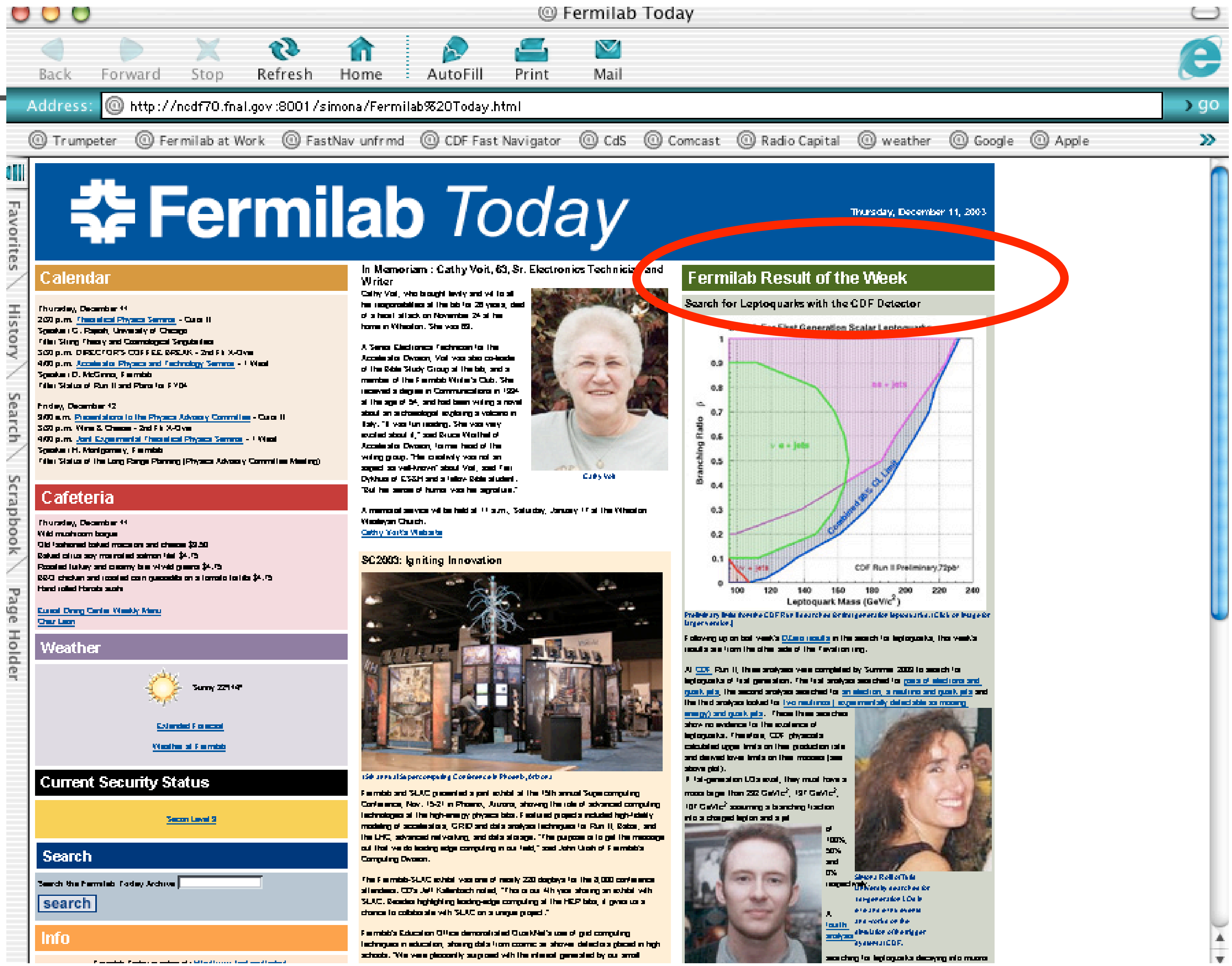
New analysis strategy
(not counting experiment anymore?)
might be necessary…….

Plans

- Papers are in preparation
  - 2 PRL's (1st and 2nd generation)
  - Godparents assigned
- Third generation LQ's
  - LQ□ □b
  - Leptonic decay of both taus will be considered first
    - Lower BR but cleaner signature (high P_T) lepton triggers
    - Hao's thesis

Tufts is the only institution in CDF doing LQ's

Press!


Fermilab Today
Back
Forward
Stop
Refresh
Home
AutoFill
Print
Mail
Address: http://ncdf70.fnal.gov:8001/simona/Fermilab%20Today.html
go
Trumpeter
Fermilab at Work
FastNav unfrmd
CDF Fast Navigator
CdS
Comcast
Radio Capital
weather
Google
Apple
Favorites
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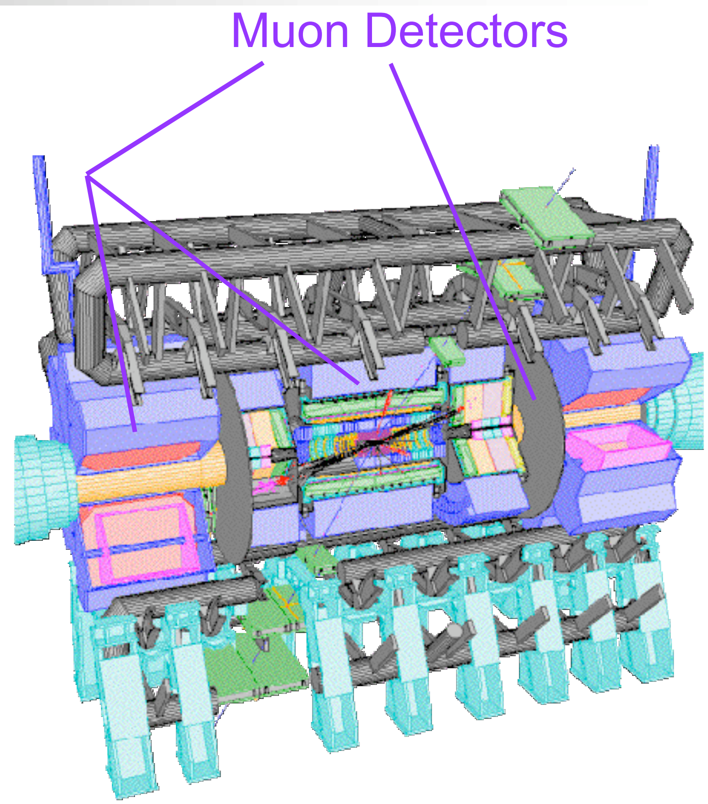
Scrapbook
Page Holder
Fermilab Today
Thursday, December 11, 2003
Calendar
In Memoriam : Cathy Voit, 63, Sr. Electronics Technician and Writer
Fermilab Result of the Week
Search for Leptoquarks with the CDF Detector
Cafeteria
Weather
SC2003: Igniting Innovation
Current Security Status
Search
search
Info
Leptoquark Mass (GeV/c²)
Branching Ratio
CDF Run II Preliminary 72pb⁻¹

Other Talks and Presentations

- Dan Ryan, DIS2004, Strbske Pleso, Slovakia, April 2004
  - Searches for LeptoQuarks at the TeVatron
- Simona Rolli, Fermilab Joint Theoretical-Experimental Seminar, April 2004
  - Recent Results on EW, Top and Exotic Physics at CDF
- S.Rolli, I.F.A.E. Torino, April 2004
  - Recent Results on Exotic Physics at the TeVatron
- S. Rolli, R.T.N, Pisa May 2004
  - Recent Results on Exotic Physics at CDF
- S. Rolli, Tev4LHC workshop, Fermilab September 2004
  - Searches fo LetpoQuarks

ATLAS

- Installation and Commissioning
  - 2004 combined test beam
    - H8 Test Beam at CERN
      - Detector slice
  - Muon Chambers certification
    - Ongoing activities
    - Plans



- Physics
  - Les Houches Workshop & TeV4LHC Workshop

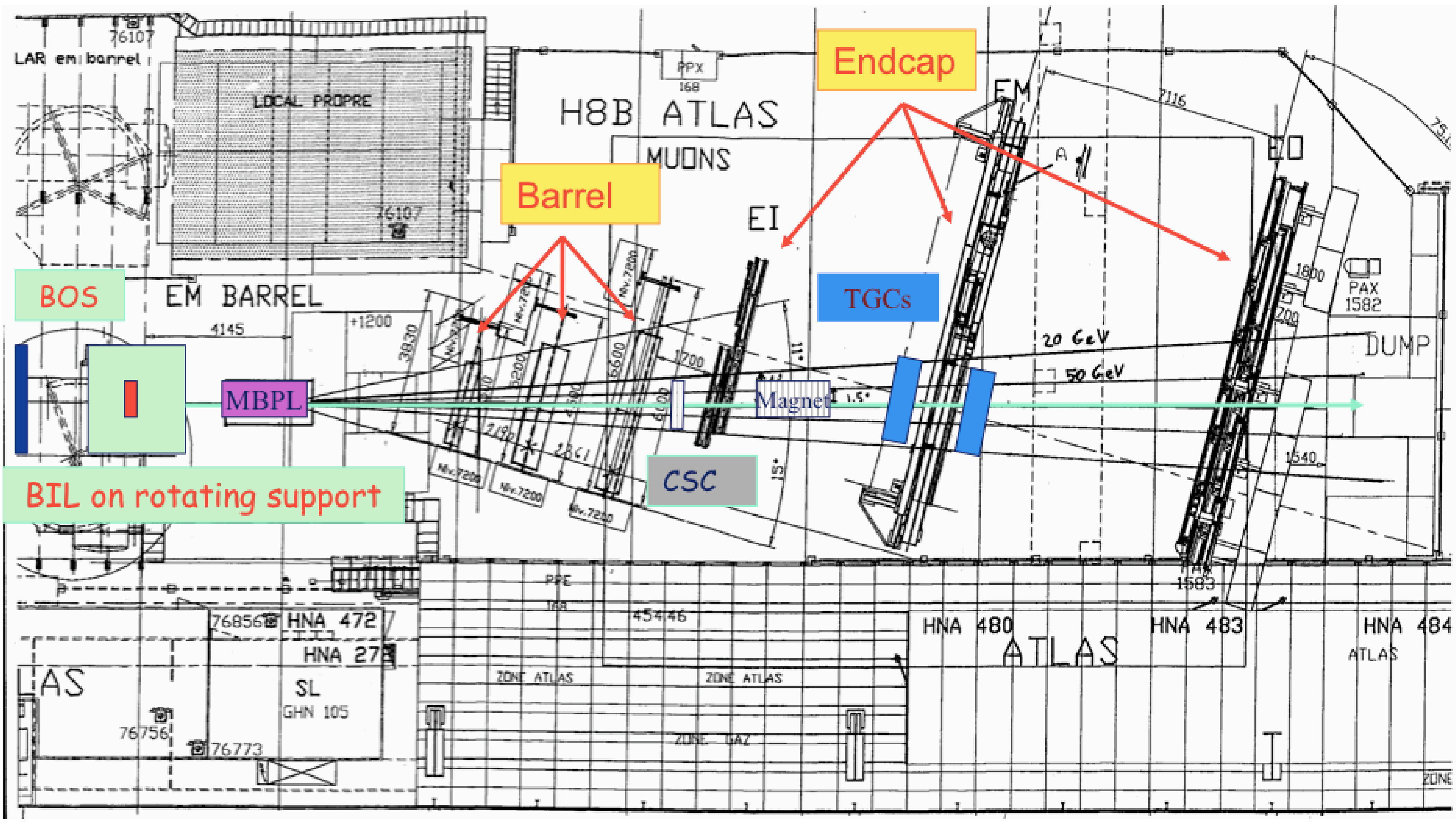
Barrel Stand

- 6 barrel MDT chambers (precision tracking)
  - ✓ Fully instrumented with FE electronics, readout with 1 MROD
  - ✓ Fully equipped with alignment system
- 6 RPC doublets (4 BML and 2 BOL) (LVL1 trigger + tracking)
  - ✓ 1 Trigger PAD
  - ✓ Being upgraded now to 4 PADS (2 LowPt, 2 HighPt)
- The setup is reproducing at full scale one ATLAS barrel sector with 6 MDT+RPC stations
- 2 additional barrel MDT chambers
  - ✓ 1 BIL on rotating support for calibration studies
  - ✓ 1 BOS station (MDT+RPC) upstream of muon wall for noise studies and CTB

Endcap Stand

- 23 MDT chambers (2 EI, 2EM, 2 EO)
  - ✓ Fully instrumented with FE electronics, readout with 1 MROD
  - ✓ Equipped with the complete alignment system (calibrated sensors for absolute alignment)
  - ✓ Reproducing at full scale a muon spectrometer endcap sector
- 3 TGC chambers (2 doublets, 1 triplet)
  - ✓ Fully instrumented with on-chamber electronics
- CSC: 1 chamber being installed during last week, should be integrated soon in the combined data taking

Muon Test Beam Setup



Data collected until now

- A large sample of data has been collected since June (and already last year)
- Main tests performed on detectors:
  - ✓ MDT LV tests in the ATLAS configuration (2 chambers/LV channel)
  - ✓ Barrel alignment: large chambers rotations up to 8 mrad
  - ✓ Endcap alignment: checks of sensors absolute calibration
  - ✓ Noise and efficiency studies on a large scale (~1% of ATLAS)
  - ✓ MDT-RPC cross talk studies
  - ✓ MDT threshold scans
  - ✓ RPC threshold and HV scans
  - ✓ LVL1 trigger validation with TGC during the 25 ns run in June
  - ✓ Muon system commissioning and integration

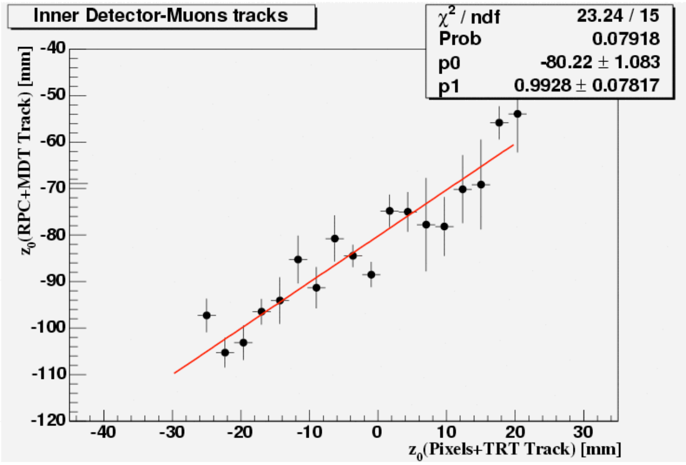
- Triggering during the muon standalone period with 10x10 or 60x100 cm^2 scintillators. Self-triggering with TGC or RPC during 25ns period
- Muon detectors are integrated in the Combined Test Beam data taking since mid of August

Offline software

- Offline algs (MOORE, Muonboy) as for physics data
- Ntuples are produced with ATHENA for offline monitoring
  - ✓ Useful tool for offline monitoring of detector performance
  - ✓ Check events correlation among subdetectors
  - ✓ Included in the Combined Ntuples

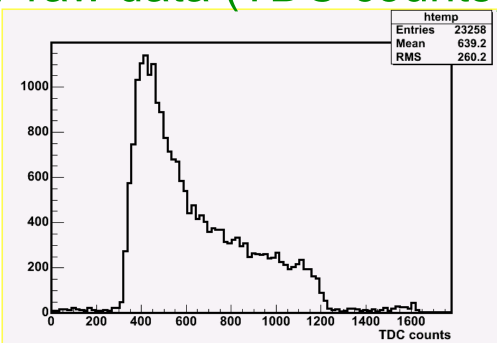
Standalone Fortran code and hbook ntuple (mutrak)
- Single tube studies
- Efficiencies;
  - drift time, R-T relationships

Correlation Muon track InDet track

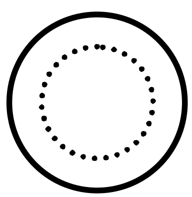


MDT Calibration Constants

MDT raw data (TDC counts)



MDT TB CalibrationSvc

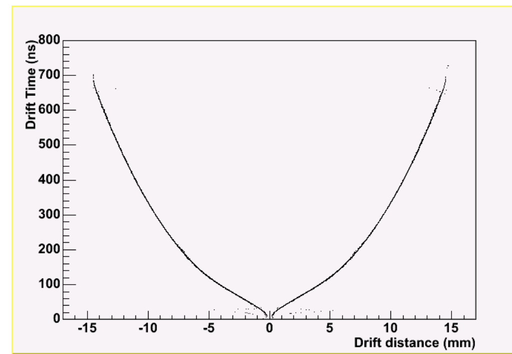


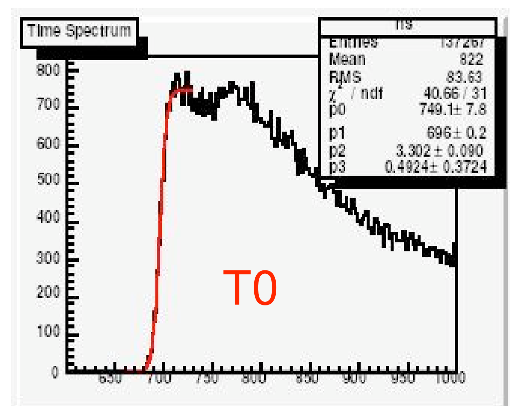
Drift circles

Pattern recognition, track fitting

Calibration constants – Preliminary!

R-t relations





Current Status of Test Beam

- The muon test beam has profited of many years of tests and experience of the muon group in H8
- Many aspects of detectors integration and combined data taking have been tested
- Data taking is going on since June, a subset of preliminary results has been shown
  - ✓ Detector and trigger performance
  - ✓ Reconstruction studies
  - ✓ Comparisons with G4 simulation
  - ✓ Alignment
- The test beam is providing feedback to offline software development and G4 simulation
  - ✓ The ATHENA framework is being used as reconstruction and analysis, and simulation tool
  - ✓ Tests of ATLAS reconstruction algs on real data
  - ✓ First comparisons of G4 simulation with real data

Plans

Jointly with Marcin Wolter:

- basic analysis of chamber performance (high intensity runs, August 2004)
  - drift times,
  - efficiency,
    - Single tubes
    - Tracking
- ATHENA agents and diagnostic codes. This work can have long term ramifications as self monitoring software will be an important part of data validation.
- Database work: installation MDT information. There needs to to be a piece of the Conditions DB which stores *all* relevant parameters to any kind of diagnostic.

Physics at LHC

Les Houches 2005

• Fourth in a series whose aim is to **bring together theorists and experimentalists** working on the phenomenology of the upcoming **TeV colliders** .

• The emphasis will be on the **physics of the LHC during its first few years of running**

- Strong interplay between:
  - what has been learned from the TeVatron
  - how the next linear collider could complement LHC measurements/findings
- The impact of cosmology and astrophysics will be addressed.
- Two WG - convener of BSM

The projects are to start in January 2005 and should be completed by the end of the year 2005.

TeV4LHC Workshop

• Bringing together the Tevatron and LHC experimental groups and the theoretical community to make the best possible use of data and experience from the Tevatron in preparing for the LHC experimental program:

- Understanding how to use Tevatron data to improve event modelling
- Theoretical understanding of cross sections for the signals and backgrounds at LHC,
- Using experience with real problems at the Tevatron